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IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

Applicant: Haumont, et al.

Serial No. TO BE ASSIGNED

Corresponding to PCT/FI98/00971, filed 11 December 1998

Filed: 9 June 2000

Docket No.: 796.354USW1

Title: LOCATION MANAGEMENT IN A MOBILE TELECOMMUNICATION  
SYSTEM

CERTIFICATE UNDER 37 C.F.R. 1.10:

'Express Mail' mailing number: EL477365771US

Date of Deposit: 9 JUNE 2000

The undersigned hereby certifies that this Transmittal Letter and the paper or fee, as described herein, are being deposited with the United States Postal Service 'Express Mail Post Office To Addressee' service under 37 CFR 1.10 and is addressed to the Assistant Commissioner for Patents, Washington, D.C. 20231

By:

Theresa Jurek

Box Patent Application  
Assistant Commissioner for Patents  
Washington, D.C. 20231

REQUEST FOR CONTINUATION OF AN INTERNATIONAL APPLICATION UNDER 37 C.F.R.  
§1.53(b)

This is a request for filing a continuation application under 37 C.F.R. §1.53(b) of prior pending international application number PCT/FI98/00971 filed on 9 June 2000 entitled LOCATION MANAGEMENT IN A MOBILE TELECOMMUNICATION SYSTEM, which designated the United States.

1. ☒ Enclosed is a patent application containing 12 pages of specification, 4 pages of claims and 4 sheet(s) of drawings.
2. ☒ A preliminary amendment is enclosed.
3. ☒ Please amend the specification by inserting the following paragraph after the title:

This application is a continuation of international application serial number PCT/FI98/00971, filed 11 December 1998.

4. ☐ Small entity status
  - a. ☐ A small entity statement is enclosed.
  - b. ☐ A small entity statement was filed in the prior non provisional application.
  - c. ☐ is no longer claimed.

The filing fee is calculated below

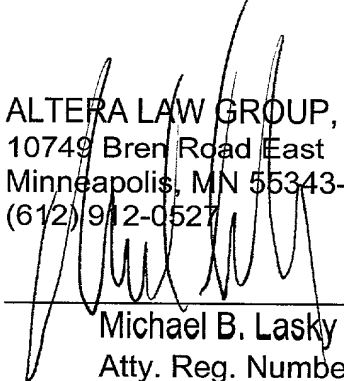
CLAIMS				
	Number Filed	Number Extra	Rate	Fee
Total Claims	21	1	X \$18.00	\$ 18.00
Indep. Claims	4	1	X \$78.00	\$ 78.00
Multiply Dependent Claims				\$
Basic Fee				\$ 690.00
TOTAL				\$ 786.00

5. ☒ Payment of filing fees  
☐ A check in the amount of \_\_\_\_\_ is enclosed.  
☐ Please charge Deposit Account Number 50-1038.  
☒ Is deferred.
6. ☒ The Commissioner is hereby authorized to credit any overpayment or charge any fees required under 37 C.F.R. §1.16-1.18 to Deposit Account Number 50-1038.
7. ☒ The priority of Finnish application number 974502, filed 12 December 1997, is claimed under 35 U.S.C. §119. A certified copy is enclosed along with a communication titled Submission of Priority Document.
8. ☒ An unsigned Declaration is enclosed.
9. ☐ An assignment of the invention to \_\_\_\_\_, Recordation Form Cover Sheet (Patents Only) and a check in the amount of \$40.
10. ☒ An Information Disclosure Statement, Form PTO 1449 and copies of 10 citations are enclosed.
11. ☒ Correspondence Address
12. ☒ Address all correspondence to Michael B. Lasky.
13. ☐ Also enclosed:
14. ☒ A return postcard is enclosed.

Respectfully submitted,

ALTERA LAW GROUP, LLC  
10749 Bren Road East  
Minneapolis, MN 55343-9056  
(612) 912-0527

Dated: 9 June 2000

  
\_\_\_\_\_  
Michael B. Lasky  
Atty. Reg. Number 29,555  
MBL/mka

S/N UNKNOWN

PATENT

IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

Applicant: Haumont, et al. Serial No.: UNKNOWN  
Filed: CONCURRENT HEREWITH Docket No.: 796.354USW1  
Title: LOCATION MANAGEMENT IN A MOBILE TELECOMMUNICATION  
SYSTEM

CERTIFICATE UNDER 37 CFR 1.10

'Express Mail' mailing label number: EL477365771US

Date of Deposit: 9 June 2000

I hereby certify that this correspondence is being deposited with the United States Postal Service 'Express Mail Post Office To Addressee' service under 37 CFR 1.10 on the date indicated above and is addressed to the Assistant Commissioner for Patents, Washington, D.C. 20231.

By: 

Name: Theresa Jurek

**PRELIMINARY AMENDMENT**

Box Patent Application  
Assistant Commissioner for Patents  
Washington, D.C. 20231

Dear Sir:

Please enter the following preliminary amendment into the above-referenced application.

**ABSTRACT**

Please insert the attached abstract into the application as the last page thereof.

**CLAIMS**

Please amend the claims as follows:

Please delete claims 1-25. Please insert attached claims 26-46 for examination.

In claim 27, line 1, please replace "claim 1" with --claim 26--.

In claim 28, line 1, please replace "claim 2" with --claim 27--.

In claim 29, line 1, please replace "claim 2" with --claim 27--.

In claim 30, line 1, please replace "claim 2" with --claim 27--.

In claim 31, line 1, please replace "claim 2" with --claim 27--.

In claim 32, line 1, please replace "claim 6" with --claim 31--.

In claim 33, line 1, please replace "claim 2" with --claim 27--.

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In claim 34, line 1, please replace "claim 1" with --claim 26--.

In claim 35, line 1, please replace "claim 1" with --claim 26--.

In claim 36, line 1, please replace "claim 1" with --claim 26--.

In claim 37, line 1, please replace "claim 1" with --claim 26--.

In claim 38, line 1, please replace "claim 12" with --claim 37--.

In claim 39, line 1, please replace "claim 12" with --claim 37--.

In claim 40, line 1, please replace "claim 1" with --claim 26--.

In claim 41, line 1, please replace "claim 1" with --claim 26--.

In claim 42, line 1, please replace "claim 16" with --claim 41--.

In claim 43, line 1, please replace "claim 16" with --claim 41--.

#### **REMARKS**

The above preliminary amendment is made to insert an abstract page into the application and to insert new claims for examination.

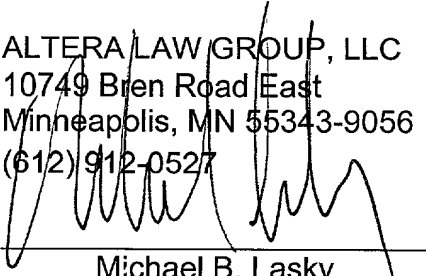
Applicant respectfully requests that this preliminary amendment be entered into the record prior to calculation of the filing fee and prior to examination and consideration of the above-identified application.

If a telephone conference would be helpful in resolving any issues concerning this communication, please contact Applicant's attorney of record, Michael B. Lasky at (952) 912-0527.

Respectfully submitted,

ALTERA LAW GROUP, LLC  
10749 Bren Road East  
Minneapolis, MN 55343-9056  
(612) 912-0527

Dated: 9 June 2000

  
\_\_\_\_\_  
Michael B. Lasky  
Atty. Reg. Number 29,555  
MBL/mka

## Location management in a mobile telecommunication system

### Field of the invention

5 This invention concerns location management in a mobile telecommunication system.

### Background of the invention

Figure 1 shows a system in which one Radio Access Network RAN is connected to a plurality of Core Networks CN. Such a RAN is planned to be implemented in the Universal Mobile Telephony System UMTS currently being standardized by ETSI (European Telecommunication Standards Institute), for example. The RAN provides the radio connection for the subscribers of a plurality of core networks and is therefore also called Generic RAN, i.e. GRAN. The services are provided by the core networks connected to the RAN using the  $I_u$  interface. In the figure, the GSM, UMTS, GPRS (General Packet Radio Service), and ISDN (Integrated Services Digital Network) core networks are shown. The Mobile Station MS can make connections to the core networks using radio connections to the RAN. The MS makes radio connections to the base stations of the radio access network. The RAN routes the connections to the core network whose service the subscriber is currently using.

Information concerning the location of the mobile station is needed in the radio access network for routing incoming calls and other services provided by the core networks. For location management, the geographical area served by a radio access network is divided into one or a plurality of Location Areas LA. The location of a mobile station is tracked with an accuracy of one location area. Within the location area, the mobile station can move without informing the RAN about its movements. The location area consists of one or a plurality of cells, a cell being the coverage area of a base station. The base stations send information about themselves continuously. This information comprises the identity and the location area of the base station. Based on this information, the mobile station knows the location area it is visiting at all times. Additionally, the mobile knows the identity of the location area of its latest location update, i.e. its currently specified location area. When recognizing that the location area identification sent by the base station having the best signal is different from the location area of

the mobile, the mobile initiates a location update procedure. In the procedure, the mobile contacts the RAN to inform it of the new location area.

The size of the location areas is always selected as a compromise. When using very small location areas, the moving mobile stations have to contact the network rather frequently to inform the network about their new location areas. The frequent location updates reserve a lot of radio transmission capacity, which can then not be used for transmission of user information. On the other hand, when using very large location areas, the mobile that is receiving a call has to be paged from a large area comprising lots of base stations thus reserving unnecessary amounts of transmission capacity. Therefore, the optimum size for a location area is a compromise depending on both the mobility of the subscribers and the amount of calls coming to the subscribers.

The location can be defined using different levels of accuracy. When using a packet switched service such as GPRS in the standby state, the location is tracked with an accuracy of a smaller location area, i.e. a routing area. This size of a routing area is smaller than the size of a location area, typically one or a few cells. When there are packets to be transferred, the service moves to the active state. For this, the mobile using the service is paged from the routing area. In the active state the location of the mobile is tracked with an accuracy of one cell. When there are no packets to be sent, the service returns to the standby state after a short delay. When the packet stream continues, the mobile is paged again from the routing area. The mobile has to be paged a plurality of times during one connection. Therefore, the number of pages made during a packet switched connection is generally much larger than the number of paging messages sent by the RAN when the mobile is in the idle state of a circuit switched connection. This is the reason for using smaller locations areas, i.e. routing areas, in packet switched services.

The location information is needed in the RAN in order to provide the radio connections for the services provided by the core networks. Hence, in a system shown in Figure 1, it is preferable to store the location information in the RAN. The services offered by a core network may also depend on the location of the subscriber, i.e. the subscriber is offered different services in different service areas. Therefore, the location updates of the mobile sub-

scriber have to be passed to the core network as well. This requires signaling and causes an unnecessary load on the  $I_u$  interface.

The problem with the prior art is the handling of location information between the RAN and the core networks. The objective of the present invention is to solve this problem. This objective is achieved using the method defined in the independent claim.

#### Summary of the invention

The basic idea of the present invention is that the definition of the location area used in the RAN is not necessarily the same as the specification of the reporting area used when reporting the location of the mobile to the core network.

The size of the location area is selected preferably by the RAN on the basis of the services used by the subscriber in order to optimize the use of radio resources. Preferably, there is a plurality of location accuracy levels, each having location areas of different sizes.

A reporting area comprises one or a plurality of location areas. The size of a reporting area is selected according to the extent of the accuracy of the location information needed in the core network. The RAN informs the core network when a subscriber moves out of his current reporting area.

A service area is the location accuracy level needed for service management purposes in the core network. It is defined in the core network but is not necessarily known by the RAN. For example, the core network may require the subscriber to reauthenticate itself when entering into a new service area. Also the billing of services may differ from service area to service area. A service area may comprise one or a plurality of reporting areas.

If the RAN uses a location area configuration comprising a plurality of location accuracy levels, the reporting area can be defined as a location area of a specified accuracy level. Alternatively, the reporting area can be equal to a service area, or some specifically specified area. In one embodiment, the service area configuration is known by the mobile station and the reporting area configuration is equal to the service area configuration.

According to one embodiment, the core network and the radio access network negotiate the size of the reporting area prior to the activation of

the service. In addition, the reporting areas can be renegotiated when the service is in the active state.

### Brief description of the figures

5           The invention is described more closely with reference to the accompanying schematic drawings, in which

Figure 1 shows a radio access network connected to a plurality of core networks;

10 Figure 2 shows location areas at three different location accuracy levels;

Figure 3 shows cells of a mobile telecommunication network belonging to three different location areas and two different reporting areas; and

Figure 4 shows signaling between the mobile station, the radio access  
15 network and the core network.

## Detailed description of the invention

According to the invention, the concepts of location area, i.e. the location information for the need of the radio access network, and the reporting area, i.e. the location information for the needs of a core network, are separately defined.

The optimal location area configuration of the RAN basically optimizes the usage of radio resources. Core networks rely on the RAN for establishing and optimizing the radio connections. However, also the core networks need location information for their own needs. An example of such need is the tracking service used to track the mobile accurately, e.g. on the accuracy level of one cell. Another example is the SolSA (Support of Localised Service Area) service being currently specified by ETSI (European Telecommunications Standards Institute). Therefore, the RAN provides the core network the location information of a mobile at the accuracy of reporting area specified by the core network. To be able to do this, the radio access network has to track the mobile at least at the accuracy level of one reporting area even if it does not optimize the usage of radio resources.

35 The optimum size for a location area, i.e. the accuracy of location tracking, depends on the mobility of the subscriber and the amount of pages made per time unit. The amount of pages is strongly dependent on the serv-



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update procedure when entering a new service area, and of instructing the radio access network to forward the new location information to the core network. This situation occurs, for example, when the localized service area configuration of a Solisa subscriber is stored in the SIM (Subscriber Identity  
5 Module) card of the subscriber. The service area configuration may be coded, e.g. by listing the cell identities of the cells belonging to the special service areas of the subscriber. Based on this information and the identity information sent by the base stations, the MS notices the change in a service area when entering a new one and initiates a location update. As an alterna-  
10 tive implementation the service area configuration may be coded as geographical coordinate information. In this case the mobile station has knowledge about its coordinates. This knowledge can be gathered e.g. by implementing a GPS (Global Positioning System) receiver in the mobile station or using localizing methods of the mobile telecommunication system. In this im-  
15 plementation the mobile initiates a location update when the coordinate information shows that it has moved to a new service area.

It is to be noted that in this embodiment the service area border is not necessarily the same as the location area border, and the service area may thus change within the location area of any location area level defined in  
20 the radio access network. However, the mobile station also informs the network also when it moves to a new service area. Thus the RAN tracks the mobile both at the location accuracy level selected by the RAN and at the service area level defined by his subscription. The subscriber thus has a personal location area configuration, the borders of his location areas being de-  
25 fined by the borders of the location areas of a location accuracy level and the borders of his personal service areas. In the context of the location update procedure, the MS instructs the RAN to report the new information about the location of the mobile to the core network. In this case, the reporting area equals the service area configuration known by the mobile station but not by  
30 the RAN.

In the following, we shall study embodiments in which the service area configuration is known by the core network. The reporting area can be specified as the location area of a specified location accuracy level shown in  
Figure 2. In this embodiment, the core network signals to the RAN the loca-  
35 tion accuracy level to be used, and the RAN reports to the core network when the mobile moves from one location area of that accuracy level to an-

other location area of the same accuracy level. The core network can define the reporting areas so that a service area is composed of a plurality of reporting areas, for example. This is preferably particularly when the reporting area is specified as a location area of a location accuracy level. In this embodiment, the reporting areas in the inner parts of the service area could be larger than the reporting areas in the border areas of two service areas. This is easily implemented by specifying the location areas of different location accuracy levels to be used as the reporting areas in different parts of the service area.

Alternatively, the CN can inform the RAN of its own service area configuration, and the RAN reports only the changes in service area, i.e. the reporting area equals the service area. This embodiment requires a larger amount of signaling when specifying the reporting area configuration or when storing the service area configurations of all the core networks in the RAN. The reporting area can also be defined using an arbitrary chosen area. The mapping between the location areas and the reporting areas may be stored in an external database. If the core network needs no information about the subscriber's location, the reporting area can be specified as comprising the whole coverage area of the RAN or by not requiring that a reporting area be specified. In this case, the location will never be reported to the core network.

The location area configuration is specified independently by the radio access network based on the optimization of radio resource usage and the size of the reporting areas specified. The location area configuration optimizing the usage of radio resources for a subscriber may be specified with the help of the past behavior of the subscriber, i.e. the rate of location updates performed and the rate of pages made by the radio access network to locate the subscriber. If the size of the reporting area is smaller than the optimal size of a location area according to radio aspects, the location area is equal to the reporting area.

According to the invention, the radio access network tracks the mobile subscriber with an accuracy of one location area. Changes in the location area are not reported to the core network unless the reporting area changes simultaneously. This can be studied with reference to Figure 3.

In the figure, a mobile subscriber moves from point A to point C via point B. On the location accuracy level used for this specific mobile, the

area shown in the figure is divided into three location areas, LA1, LA2 and LA3. The location areas each comprise a plurality of cells. For each cell, the base station of the cell transmits the location area code(s) of the location area(s) the cell belongs to. If there is a plurality of location accuracy levels, the cells transmit the location area codes of all the location areas they belong to at the different accuracy levels. In addition to the location area configuration, the area is divided into two reporting areas, Reporting Area 1 and Reporting Area 2. The mapping of the cells to different reporting areas is only known by the RAN, and the reporting areas are the location areas of one location accuracy level, for example. However, it must be noted that the reporting areas may also be specified in some other way without losing the general applicability of this example.

In point A, the subscriber is registered in location area LA2 comprising cells 21,22,23,26 and 27 shown in the figure using backward hatch. The mobile station of the subscriber listens to the signals sent by the base stations of the RAN and knows the location area based on the Location Area Code LAC LAC2 transmitted by the base station of cell 22, the cell the mobile is currently visiting.

As the subscriber moves onward, he passes point B belonging to another location area LA1 shown in the figure using a forward hatch. The mobile station of the subscriber determines this based on the location area code LAC1 of the new cell 15 now having the strongest signal at the site of the mobile. Based on the observed change in the location area code, the mobile station initiates a location update procedure. In the procedure, the mobile station initiates a connection with the radio access network to inform it of its new location area. The radio access network, in turn, determines that both LA1 and LA2 belong to the same reporting area, and the reporting area of the mobile phone thus does not change. Therefore, the core network receives no report as to the new location of the subscriber.

As the subscriber moves onward to point C, the signal sent by the base station of cell 33 gets stronger than the signal sent by the base station of cell 15. Therefore, his mobile starts to listen to and decode the signal of cell 33. Cell 33 belongs to location area LA3 shown in the figure using vertical hatch. The location area code LAC3 included in the signal indicates that the subscriber has again entered a new location area. Therefore, the mobile contacts the radio access network to inform it of the new location of the mo-

bile subscriber. The radio access network receives this information, and, on the basis of the reporting area configuration defined by the core network determines that the old location area LA1 belongs to reporting area 1 and the new location area LA3 belongs to another reporting area, reporting area 2.

- 5 Therefore, the radio access network sends the core network notification of the new location of the subscriber.

In response to having received information about the new location of the subscriber, the core network updates this information into its memory. If the subscriber has rights to the same services in both the old and the new  
10 reporting areas, the core network returns the radio access network a message indicating that no changes in the services offered are to take place. If the rights differ, the radio access network is informed about the new rights such as limits as to the bit rates the subscriber may use.

- We shall next study what kind of information is transferred in the  
15 location and reporting area updates. An exemplary signaling chart showing the signaling according to the invention is shown in Figure 4. The signaling follows the example presented in Figure 3.

The procedure starts when the mobile station MS at point A of Figure 3 requests a service provided by a core network by sending the message K01 to the radio access network RAN. The RAN forwards the request to the core network CN in the message K02. The core network consults its  
20 subscriber database at stage K03 to check whether the subscriber is entitled to the requested service. The service is activated if the subscriber has rights to the service. In addition, the core network determines the service parameters for the service, such as the reporting areas to be used, the rights of the subscriber, e.g. the Quality of Service QoS the subscriber is entitled to in his present reporting area, and the reporting type, as well as service characteristics. The service characteristics are information concerning the service that the RAN is using to determine the optimal location area configuration from  
25 the point of view of radio efficiency.

- The reporting can be either indicative or determining, for example. Indicative reporting is used when the subscriber has the same rights in every reporting area, but the core network still wants to have some information about the location of the subscriber. Such reporting can be used for tracking  
35 services, for example. In the case of indicative reporting, the radio access network only informs the core network of the new reporting area of the sub-

scriber. On the other hand, determining reporting is used when the services the subscriber is entitled to depend on the reporting area of the subscriber. In this case, the radio access network has to wait for the new set of service parameters provided by the core network before accepting the subscriber's location update for a new reporting area.

The core network reports the reporting area and other parameters determined for the connection to the radio access network in the message K04. The radio access network stores this information in its memory at stage K05. Based on the characteristics of the activated service (or services), the reporting area defined by the core network (or core networks), and possibly the past behavior of the subscriber, the radio access network defines the level of location accuracy used for the subscriber. The RAN defines identification LA2 of the current location area of the subscriber, and reports the relevant information to the mobile station in message K06. At this stage, the mobile station can start using the services provided by the core network.

After some time, the mobile station has moved to point B in Figure 3, i.e. from the first location area LA2 to a second location area LA1. The mobile station recognizes that the location area identification it was given is no longer found in the best signal at the site of the mobile station. Therefore, the mobile station initiates a location update procedure by sending the radio access network a location update message K08. In response to having received the message, the RAN checks at stage K09 the subscriber information stored in its memory. Based on the check the RAN determines that the new location area LA2 of the mobile belongs to the same reporting area as the old location area LA1. Therefore, the location update will not be forwarded to the core network, but the RAN determines according to its own criteria, such as radio criteria, whether the location update should be accepted (ACC) or rejected (REJ). This information is then returned to the mobile station in the message K10 to complete the location update procedure.

The mobile station moves on and arrives at point C in Figure 3. Again, it recognizes that it has entered a new location area at stage K11 and sends the radio access network a location update message K12. In response to having received the message, the RAN checks at stage K13 the subscriber information stored in its memory. Based on the information, the RAN determines that in addition to the location area, also the reporting area of the subscriber has changed. Thus, the RAN sends the core network a reporting

area update message K14. If the reporting is defined as indicative, the radio access network will immediately send the mobile station the message K18 concluding the location update procedure. If the reporting is defined as determining, the radio access network waits for a response from the core network.

In response to having received the message K14, the core network stores the new location information and checks the subscriber information of the subscriber at stage K15. In the new reporting area, the subscriber may have different service parameters than it has in the old reporting area. For example, the subscriber may have rights for both speech and multimedia services in the old reporting area, but only for speech in the new reporting area. It is also possible that the subscriber has no rights to any service in the new reporting area. Additionally, the Quality of Service QoS the subscriber is entitled to may differ from reporting area to reporting area. The core network may also request the mobile station to reauthenticate itself in connection with the service area update.

Having defined the service parameters, the possible request of reauthentication procedure, etc., the core network sends this information to the radio access network in message K16.

The radio access network receives message K16 and modifies the subscriber information of that subscriber in its memory at stage K17. The radio access network then defines the identity of the new location area of the subscriber and sends this information to the mobile station together with other relevant information concerning the new reporting and location areas in message K18.

To implement the invention, the radio access network must be adapted to

- store information concerning a plurality of location areas and a reporting area comprising at least one location area,
- tracking the mobile station with an accuracy of one location area, and
- reporting to the core network the changes in location with an accuracy of one reporting area.

Preferably, the RAN is in addition adapted to negotiate the size of the reporting area with the core network. These arrangements may either all

be centrally implemented in one network element or distributed over a plurality of network elements of the RAN.

The core network, on the other hand, must be adapted to receive messages reporting the changes in the location of a mobile station with an accuracy of one reporting area and to define the current service area of the mobile station based on the reported location. The core network is in addition preferably adapted to negotiate the size of the reporting area with the radio access network. As for the RAN, these arrangements may either all be centrally implemented in one network element or distributed over a plurality of network elements of the core network.

As an advantage of this invention, the accuracy of location information held in the core networks is optimized for the needs of the core network, which is independent of the needs of the radio access network. This reduces signaling over the  $I_u$  interface and unnecessary control operations run in the core network.



1. A method of location management in a mobile telecommunication system comprising mobile subscribers and their mobile stations, at least one core network providing telecommunication services and a radio access network providing connections between the mobile stations and the core network, and in which system information concerning the location of the mobile station is stored in the radio access network,

characterized in that

a plurality of location areas and a reporting area comprising at least one location area are defined,

the radio access network tracks the mobile station with an accuracy of one location area, and

the radio access network reports to the core network the changes in location with an accuracy of one reporting area.

2. A method according to claim 1, characterized in that a plurality of location accuracy levels is defined, each location accuracy level having location areas of different sizes, and the radio access network selects one of these accuracy levels to be used for tracking the mobile station.

3. A method according to claim 2, characterized in that the reporting area is a location area of one location accuracy level.

4. A method according to claim 2, characterized in that the radio access network selects the location accuracy level based on the services the mobile subscriber is currently using.

5. A method according to claim 2, characterized in that the radio access network selects the location accuracy level based on service parameters given by the core network.

6. A method according to claim 2, characterized in that the radio access network selects the location accuracy level based on the past behavior of the mobile subscriber.

7. A method according to claim 6, characterized in that the behavior of the mobile subscriber is determined based on the number of pages the radio access network has performed to locate the mobile station and the number of location updates the mobile station has performed.

8. A method according to claim 2, characterized in that the radio access network informs the mobile station of the location accuracy level to be used when tracking the mobile station.

9. A method according to claim 1, characterized in that the core network requests that a mobile station reauthenticates itself when the mobile phone moves to a new reporting area.

10. A method according to claim 1, characterized in that  
5 the mobile station is entitled to different services in different reporting areas.

11. A method according to claim 1, characterized in that the mobile station is entitled to different qualities of service in different reporting areas.

12. A method according to claim 1, characterized in that  
10 the core network and the radio access network negotiate the size of the reporting area to be used.

13. A method according to claim 12, characterized in that the negotiation takes place when the service is activated.

14. A method according to claim 12, characterized in  
15 that the negotiation takes place when the service is in an activated state.

15. A method according to claim 1, characterized in that the service parameters for different service areas for the services the mobile subscriber has subscribed to are specified and stored in the core network,

20 the mobile station of the subscriber initiates a location update procedure when entering into a new reporting area,

in response to having received the location update message, the radio access network forwards the new location information of the mobile station to the core network,

25 the core network receives the new location information and defines the new service area of the subscriber, checks the service parameters of services the mobile subscriber is entitled to in the new service area, and sends the radio access network information about the new service parameters,

30 the radio access network receives the information about the new service parameters and completes the location update procedure by sending the mobile station an answer.

16. A method according to claim 1, characterized in that  
35 information about service area configuration is stored in the mobile station, and when entering a new service area, the mobile station initiates a location update procedure, instructing the radio access network to

forward the new location information to the core network, and  
the radio access network forwards the location information to the  
core network.

17. A method according to claim 16, characterized in  
5 that the information about the service area configuration is given as a list of  
cells.

18. A method according to claim 16, characterized in  
that the information about the service area configuration is given as coordi-  
nates of the service area and the mobile station observes its coordinates and  
10 initiates a location update when entering into a new service area.

19. A network element for a radio access network in a mobile tele-  
communication system comprising mobile subscribers and their mobile sta-  
tions, at least one core network providing telecommunication services and a  
radio access network providing connections between the mobile stations and  
15 the core network, and in which system information concerning the location of  
the mobile station is stored in the radio access network,

characterized in that the network element is adapted to  
store information concerning a plurality of location areas and a re-  
porting area comprising at least one location area,

20 tracking the mobile station with an accuracy of one location area,  
and

reporting to the core network the changes in location with an ac-  
curacy of one reporting area.

20. A network element as defined in claim 19, character-  
25 ized in that the network element is in addition adapted to negotiate the  
size of the reporting area with the core network.

21. A radio access network for a mobile telecommunication sys-  
tem comprising mobile subscribers and their mobile stations, at least one  
core network providing telecommunication services, and a radio access net-  
work providing connections between the mobile stations and the core net-  
30 work, and in which system information concerning the location of the mobile  
station is stored in the radio access network,

characterized in that the radio access network is  
adapted to

35 store information concerning a plurality of location areas and a re-  
porting area comprising at least one location area,

tracking the mobile station with an accuracy of one location area,  
and

reporting to the core network the changes in location with an accuracy of one reporting area.

5            22. A radio access network as defined in claim 21, c h a r a c -  
t e r i z e d in that the radio access network is in addition adapted to negoti-  
ate the size of the reporting area with the core network.

23. A radio access network for a mobile telecommunication system comprising mobile subscribers and their mobile stations, at least one core network providing telecommunication services, and a radio access network providing connections between the mobile stations and the core network, and in which system information concerning the location of the mobile station is stored in the radio access network on the accuracy of one location area and in the core network on the accuracy of one service area,

15 characterized in that the core network is adapted to  
receive messages reporting the changes in the location of a mo-  
bile station with an accuracy of one reporting area and

to define the current service area of the mobile station based on the reported location.

20 24. A core network as defined in claim 23, characterized in that the network element is in addition adapted to negotiate the size of the reporting area with the radio access network.

25 25. A mobile station for a mobile telecommunication system comprising mobile subscribers and their mobile stations, at least one core network providing telecommunication services and a radio access network providing connections between the mobile stations and the core network, and in which system information concerning the location of the mobile station is stored in the radio access network as to the accuracy of one location area and in the core network as to the accuracy of one service area.

30 characterized in that the mobile station is adapted to  
store information about the service areas of the subscriber, and  
when entering a new service area, to

initiate a location update procedure and to instruct the radio access network to forward the new location information to the core network.

Figure 1 consists of 12 micrographs labeled (a) through (l), arranged vertically. Each micrograph shows a different stage of larval development. (a) shows a small, round fertilized egg. (b) through (e) show the cleavage stages: 2-cell, 4-cell, 8-cell, and morula. (f) shows the blastula stage with a distinct outer layer. (g) shows the gastrula stage with internal structures. (h) shows the neurula stage with a prominent neural tube. (i) shows the tail bud stage. (j) shows the hatching stage with the larva beginning to emerge. (k) and (l) show the hatched larva, which is more elongated and has visible internal organs.

The basic idea of the invention is to separate the location area used in the RAN and the reporting area used when reporting the location of the mobile to the core network. The size of the location area is selected preferably in the RAN based on the services used by the subscriber to optimize the use of radio resources. A reporting area comprises one or a plurality of location areas. The size of a reporting area is selected based on the accuracy of location information needed in the core network. The RAN informs the core network when a subscriber moves out of his current location area. The core network and the radio access network negotiate the size of the reporting area prior to the activation of the service. Additionally, the reporting areas can be renegotiated when the service is in the active state.

### Claims

24. A method of location management in a mobile telecommunication system comprising mobile subscribers, mobile stations, at least one core network providing telecommunication services, and a radio access network  
5 providing connections between the mobile stations and the core network, and in which system information concerning a location of a mobile station is stored in the radio access system, characterized in that

the radio access system uses a location area configuration to track the location of the mobile station on the accuracy of one location area,

10 determining in the core network a service area comprising at least one location area,

informing the radio access network of the service area determined,  
receiving by the radio access network a location update from a mobile station,

15 determining based on the location update whether or not the mobile station has exceeded the border of the service area, and

sending the core network a report if the mobile station has exceeded the border.

21 A method according to claim 1, wherein a plurality of location accuracy levels is defined, each location accuracy level having location areas of different sizes, and the radio access network selects one of these accuracy levels to be used for tracking the mobile station.

22 A method according to claim 2, wherein the reporting area is a location area of one location accuracy level.

25 24. A method according to claim 2, wherein the radio access network selects the location accuracy level based on the services the mobile subscriber is currently using.

30 26 A method according to claim 2, wherein the radio access network selects the location accuracy level based on service parameters given by the core network.

31 A method according to claim 2, wherein the radio access network selects the location accuracy level based on the past behavior of the mobile subscriber.

32 A method according to claim 6, wherein the behavior of the mobile subscriber is determined based on the number of pages that the radio ac-

41) . A method according to claim 1, wherein

35 use a location area configuration to track the location of the mobile  
station on the accuracy of one location area,

[illegible]





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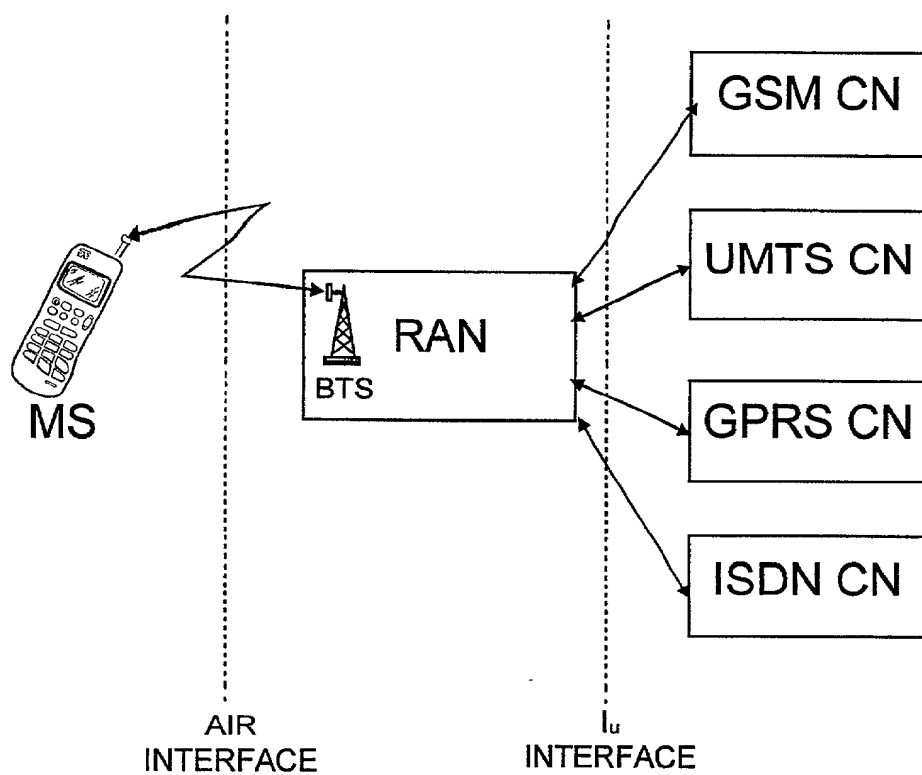
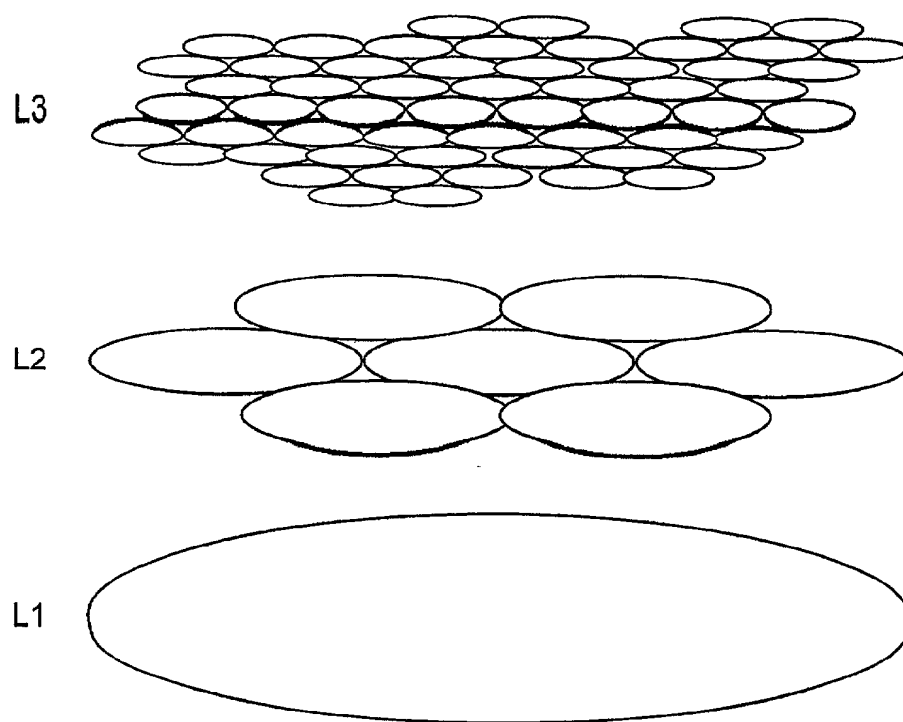


FIG. 1.



**FIG. 2.**

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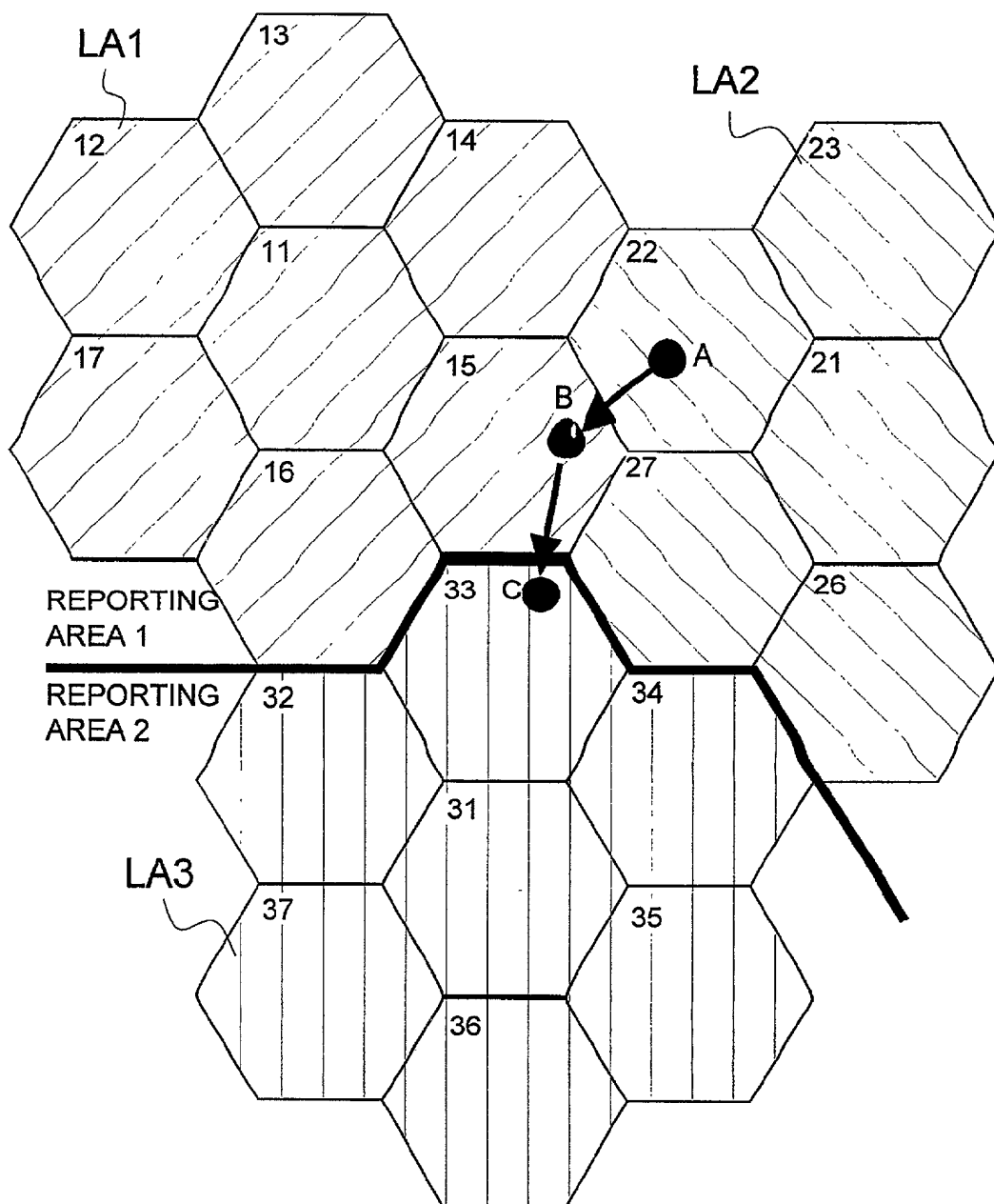


FIG. 3.

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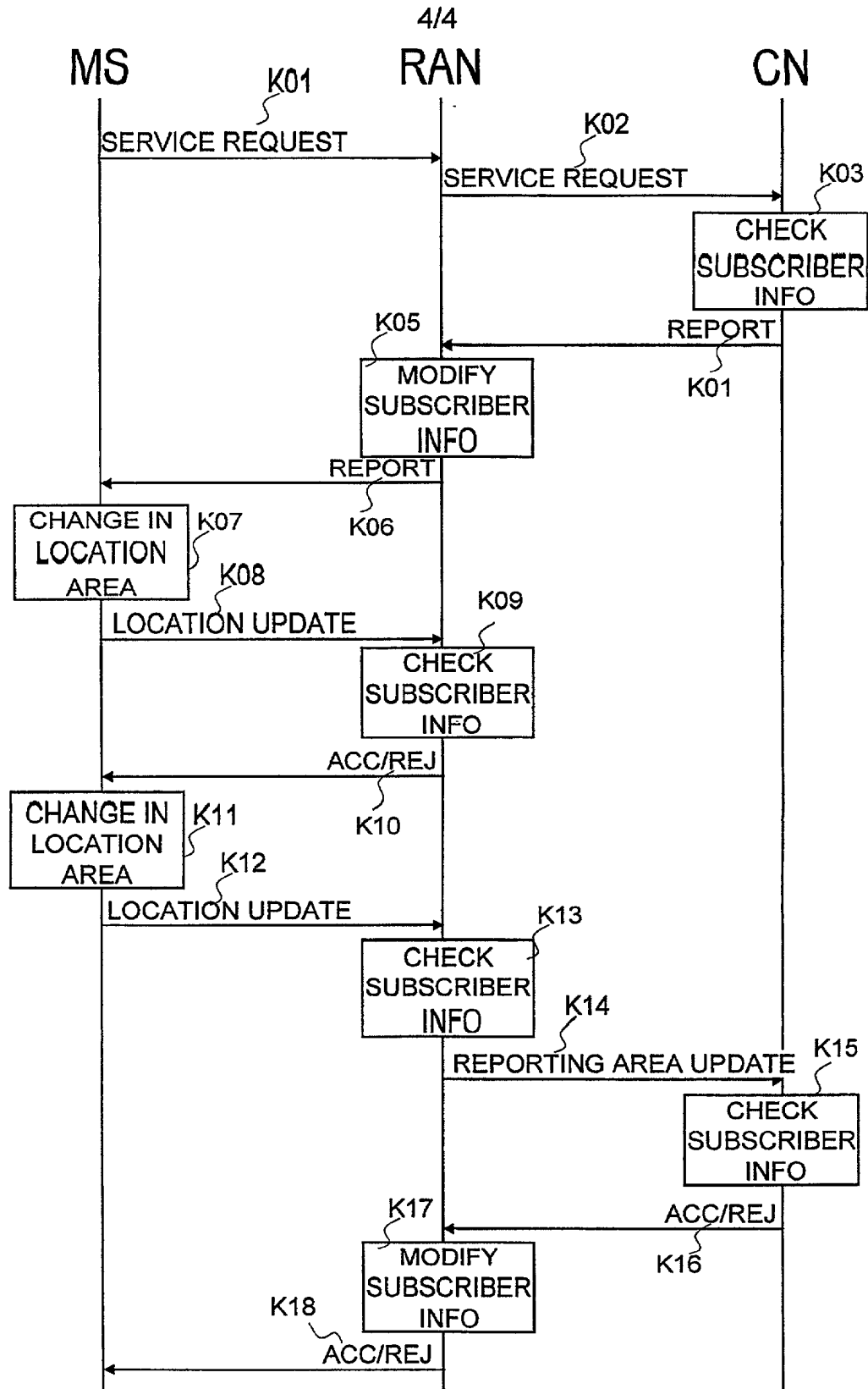


FIG. 4.

## Declaration and Power of Attorney Patent Application (Design or Utility)

As a below named inventor, I hereby declare that:

My residence, post office address and citizenship are as stated below next to my name,

I believe I am the original, first and sole inventor (if only one name is listed below) or an original, first and joint inventor (if plural names are listed below) of the subject matter which is claimed and for which a patent is sought on the invention entitled: LOCATION MANAGEMENT IN A MOBILE TELECOMMUNICATIONS SYSTEM

the specification of which

- ☐ is referred to by Altera reference number on a separate document  
☐ is attached hereto  
☐ was filed on \_\_\_\_\_ as application serial no. \_\_\_\_\_ and or PCT International  
 Application number \_\_\_\_\_ and was amended on \_\_\_\_\_ (if applicable).

I hereby state that I have reviewed and understand the contents of the above-identified specification, including the claims, as amended by any amendment referred to above.

I acknowledge the duty to disclose to the U.S. Patent and Trademark Office all information know to me to be material to patentability as defined in 37 C.F.R. §1.56.

I hereby claim foreign priority benefits under 35 U.S.C. §119(a)-(d) or 35 U.S.C. §365(b) of any foreign application(s) for patent or inventor's certificate, or 35 U.S.C. §365(a) of any PCT International application which designated at least one country other than the United States, listed below and have also identified below any foreign application for patent or inventor's certificate of PCT International application having a filing date before that of the application on which priority is claimed.

Prior Foreign Application(s)		
Number 974502	Country Finland	Day/Month/Year Filed 12 December 1997
Number	Country	Day/Month/Year Filed
Number	Country	Day/Month/Year Filed

Prior Provisional Application(s)	
Serial Number	Day/Month/Year Filing Date
Serial Number	Day/Month/Year Filing Date
Serial Number	Day/Month/Year Filing Date

Prior U.S. or International Application(s)		
Serial Number PCT/FI98/00971	Day/Month/Year Filed 11 December 1998	Status (patented, pending, abandoned) Pending
Serial Number	Day/Month/Year Filed	Status (patented, pending, abandoned)
Serial Number	Day/Month/Year Filed	Status (patented, pending, abandoned)

I hereby declare that all statements made herein of my own knowledge are true and that all statements made on information and belief are believed to be true; and further that these statements are made with the knowledge that willful false statements and the like so made are punishable by fine or imprisonment, or both, under 18 U.S.C. § 1001 and that such willful false statements may jeopardize the validity of the application or any patent issued thereon.

## Power of Attorney

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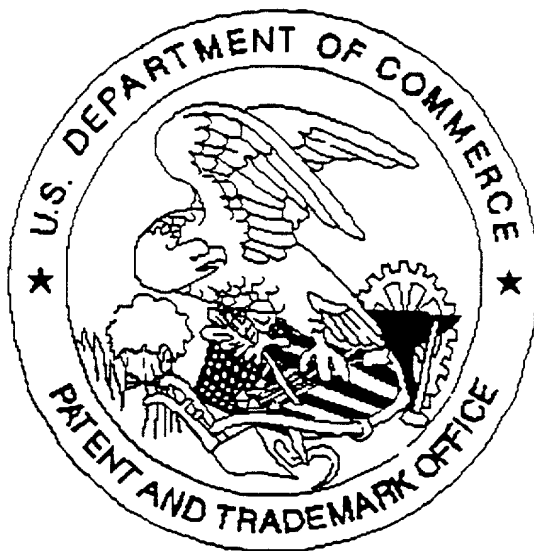
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*There are 4 extra sheets of amended claims*